

REMARKS

Status of Application

Claims 1-10 and 13-15 are pending. Claims 11-12 and 16-105 have been withdrawn as directed to non-elected inventions. These claims have been cancelled without prejudice to their prosecution in other application(s).

Independent claims 1 and 5 have been amended such that the pre-formed alpha-alumina carrier comprises particles which have at least one substantially flat major surface having a lamellate or platelet morphology. Support for these amendments can be found at least at page 7, lines 11-14 of the present application. Independent claims 1 and 5 have further been amended to add the phrase "to react the modifier with a surface of the alpha-alumina". Support for these amendments can be found at least at page 3, line 34 through page 4, line 8, and page 9, line 29 through page 10, line 5.

Submission of Declaration

Applicants submit the attached declaration of Dr. Juliana Serafin. The declaration demonstrates that when nepheline syenite, an alkali silicate containing compound, is added to the alpha-alumina precursor materials at a level of less than 3 wt% (Comparative Carriers 1, 2, 3), only a small fraction of the silicate originally introduced as nepheline syenite remains in the finished (pre-formed) carrier. When nepheline syenite is added at 4 wt % (Comparative Carrier 4), the alpha-alumina precursors do not fully convert into the alpha-alumina phase, which means that not all of the alumina forms the desired platelet morphology. Comparative Carriers 1, 2 and 3 were made into catalysts.

As more fully explained in the declaration, the results of testing the catalysts made from the Comparative Carriers 1, 2 and 3 were compared against the catalysts which were made by treating a pre-formed carrier with a sodium silicate modifier to react with a surface of the alpha alumina. The presence of nepheline may be an indicator of such reaction. The results demonstrate that the catalysts which were made according to the invention by adding the modifier to the pre-formed alpha-alumina experienced a reduction in activity and efficiency aging rates as compared to those catalysts which were made from Comparative Carriers 1, 2 and 3.

Applicants respectfully submit that the declaration demonstrates that the technical effect of adding the modifier to the preformed alpha-alumina demonstrates surprising and unexpected results.

Claim Rejections - 35 U.S.C. § 103 (a)

Claims 1, 5-7, and 10 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over US 5,733,842 by Gerdes et al, with motivation additionally supplied by US Patent No. 6,802,878 by Monroe.

The Examiner states that Gerdes recites a method of preparing a catalyst carrier by providing a mixture of components with at least one modifier selected from alkaline earth silicates and shaping to form an alpha alumina carrier precursor, followed by drying the carrier and calcining the carrier. The Examiner maintains that Gerdes teaches that the catalyst carrier “may comprise a number of other ceramic-forming component, such as titania, and that such a component may be added in the initial mixture or may be added to the porous calcined carrier by impregnation”, citing Gerdes at column 5, lines 28-36. The Examiner concludes that it would have been obvious for one of skill in the art at the time the invention was made “to form an alpha-alumina carrier and subsequently impregnate following calcination”, in view of the entire teaching of Gerdes. According to the Examiner, the suggestion or motivation is evidenced, both in Gerdes and evidentiary document to Monroe, to use a known technique to yield predictable results with expected success since it is known to add modifiers by impregnation subsequent to drying and calcining. The Examiner further cites Gerdes as support for the rejection of claims 5, 6, 7, and 10.

Applicants respectfully traverse this rejection. Gerdes does not disclose alpha-alumina carrier which comprises particles which have at least one substantially flat major surface having a lamellate or platelet morphology. Nor does Gerdes teach any modifications to the precursors of such a carrier or to such a pre-formed carrier. What Gerdes teaches at column 5, lines 39-44 are the various *shapes* into which the carrier mixture can be formed—pellets, cylinders, rings and the like. Gerdes also teaches away from platelets, in that at column 3, lines 62-67, it states “the particles can have any desired configuration but since the objective is to produce a carrier material with a high but uniform porosity, this is most efficiently achieved if the larger particles *have a generally blocky, (that is more nearly spherical), configuration*. In the same way the smaller particles are also preferably somewhat blocky in shape. a generally block, (that is more nearly spherical) configuration is preferred.

In the present office action, the Examiner has maintained that the teachings of Gerdes as a whole does allow for modifiers, such as titania, to be added post-formation by impregnation. Taking the teachings of Gerdes as a whole however, does not suggest that *any* modifier can be added *either* to the precursor or to the formed carrier. For example, Gerdes identifies calcium and magnesium silicates as being replacements for a bonding agent. Gerdes, col. 5, lines 10-16. By definition, a bonding agent is used during the formation of a

carrier. A bonding agent is not used after the carrier is formed. Titania is not taught as a bonding agent, but rather as a component to enhance a physical property, such as strength. Thus, there is no reason one of skill in the art would equate using an alkaline silicate in the same way as titania. Moreover, as is recognized in the present application, the presence of a halide is necessary for forming the platelets. Adding the modifier of Gerdes prior to calcination of the carrier would result in the elimination of some or all of the halide ions, which would then not be available for assisting in the formation of the platelets of alpha-alumina. See application at, page 6, lines 27-page 7, lines 1-5. In particular, where, as in the present case, adding the at least one modifier selected from alkaline earth silicates to the precursor would *prevent* the practice of the claimed invention, one of skill in the art would not then be drawn by Gerdes' teaching to consider applying that very same compound as a modifier to a formed carrier.

Further, in contrast to Gerdes' search for materials which can be used to contribute to *physical* properties of a carrier, the processes of the present invention use modifiers to react with, that is, to modify the *chemical* nature of the alpha-alumina surface, in addition to physical properties, if any, which may be affected. The present application teaches:

Further, while not to be constrained by any particular theory, it is believed that during the calcination step of the present invention that the at least one alkali metal silicate and/or at least one alkaline earth metal silicate can react with the alumina surfaces, particularly in instances where there was a relatively high concentration (for example, 2 wt%) of the modifier (that is, at least one alkali metal silicate and/or at least one alkaline earth metal silicate) in the modifier impregnating solution. In the case where alpha-alumina is impregnated with sodium silicate modifier, such reaction is believed to result in the emergence of Na-Al-Si-O compounds in the alumina, for example nepheline ($\text{NaAlSi}_3\text{O}_8$). The presence of nepheline is believed to signify that a reaction as referred to above in this paragraph has occurred, however, it has been found that good performance (that is activity, efficiency and aging) is obtained whether or not nepheline is present in the modified carrier. If the temperature during the calcining carried out subsequent to the impregnation of alpha-alumina with sodium silicate is about 1400 degrees C, there is also formed carnegieite phase.

One of skill in the art would read Gerdes to suggest that *physical properties* would be affected by a titania modifier. There is no suggestion in Gerdes that any *chemical properties* of the preformed alpha alumina carrier would be modified by the addition of titania. Thus, even if titania can be added either prior to carrier formation or after carrier formation, there is nothing to suggest to one of skill in the art that the same would hold true for a modifier meant to react with the surface of the *alpha*-alumina and to affect the chemical properties. Nor does the citation to Monroe fill this void. Monroe also teaches that the additions are typically made to alter or otherwise modify the *physical* properties and/or microstructure of the

sintered abrasive particles. (col. 1, lines 36-39) Thus, the Examiner is incorrect to rely upon Gerdes as rendering the claims unpatentable, either alone or in combination with Monroe.

Claims 2-3 and 15 are rejected under 35 U.S.C. § 103 (a) as being unpatentable over Gerdes et al., in view of EP 1086743 by Mikawa et al. The Examiner states that Gerdes' teaching is mentioned above in the 103 rejection. Further, with respect to claims 2-3, the Examiner asserts that Gerdes "further teaches a method of making a porous catalyst carrier comprising the steps of impregnating a preformed alpha-alumina carrier with alkaline earth metal silicate modifier, drying the impregnated carrier, and calcining the dried carrier." The Examiner admits that Gerdes does not teach the selection of the modifier from the group of sodium silicates, lithium silicates and potassium silicates, or mixtures thereof, and furthermore, Gerdes does not teach a sodium silicate modifier with stoichiometry $\text{Na}_2\text{O}-2.6\text{SiO}_2$. The Examiner finds that Mikawa teaches a method of making a catalyst for the production of epoxides by a vapor phase oxidation of an unsaturated hydrocarbon, where a sodium silicate modifier along with an alpha-alumina carrier is used. The modifier may be sodium silicate with a stoichiometry of $\text{Na}_2\text{O}-2.6\text{SiO}_2$. Thus, the Examiner concludes that "it would have been obvious to a person of ordinary skill in the art at the time the invention was made to perform the method of Gerdes using sodium silicates (alkali metal silicates) in place of magnesium and calcium silicates (alkaline metal silicates). The suggestion or motivation for doing so would have been to provide a functional equivalent." With respect to claim 15, the Examiner finds that Gerdes explicitly teaches a method that ends with the calcination of the dried carrier and that Gerdes does not expressly teach that the carrier is washed after calcination. Mikawa teaches washing a modified carrier after calcination. Thus, the Examiner concludes that it would have been obvious to one of skill in the art at the time the invention was made to perform the process set forth by Gerdes including a washing step after calcination. The suggestion or motivation to do so would have been to remove impurities from the carrier.

Applicants respectfully traverse this rejection. Applicants' comments regarding Gerdes are set forth above. Further, applicants strenuously disagree that "Gerdes teaches a method of making a porous catalyst carrier comprising the steps of impregnating a *preformed alpha-alumina carrier with alkaline earth metal silicate modifier*, drying the impregnated carrier, and calcining the dried carrier." As explained above, Gerdes' teachings are limited to the use of alkaline earth metal silicates *as components of the carrier precursor*.

Applicants must also respectfully disagree with the Examiner regarding the arguments which were made in the prior response regarding the combination of Mikawa and Gerdes. Applicants maintain that the use of Mikawa as a prior art reference, alone or in

combination with Gerdes, is inappropriate. Further, even if properly combined, the combination does not lead one of skill in the art to the claimed invention.

First, Mikawa is non-analogous art, as one of skill in the art of making a carrier to be used in the vapor phase oxidation of ethylene oxide would not look to art concerning the oxidation of unsaturated hydrocarbons *having 4 to 20 carbon atoms* (Mikawa, paragraph [0001]). Mikawa itself teaches that the catalysts which are used for the production of ethylene oxide, when used in the reaction for producing 3, 4-epoxy-1-butene by the catalytic vapor phase oxidation of 1, 3-butadiene *"generally manifest substantially no catalytic activity, or if catalytically active at all, offer very short service lives as a catalyst"*. (Mikawa, paragraph [0004]) Other references also teach that catalysts used in the epoxidation of ethylene do not have the same effects as catalysts for the epoxidation of olefins having a higher number of carbon atoms. See, e.g., Monnier, The role of Alkali Promoters in the Ag-catalyzed Epoxidation of Olefins, 234th ACS National Meeting, Boston, MA, United States, August 19-23, 2007 (2007) (cesium promoted silver based catalysts used in epoxidation of higher olefins have higher activity, selectivity, and extended catalyst lifetimes, whereas cesium promoted silver based catalyst used to epoxidate ethylene oxide increase selectivity at the expense of activity; rubidium and titanium promoters exhibit similar behavior similar to cesium for butadiene epoxidation, while potassium promoters have no effect on Ag for butadiene epoxidation); Monnier, et al., Stability and Distribution of Cesium in Cesium Promoted Silver Catalysts used for Butadiene Epoxidation, Journal of Catalysis (2004), 226(2), 401-409 (catalysts used for butadiene epoxidation contain much higher levels of cesium promoters (600-1400 ppm) compared to catalysts used for ethylene epoxidation (200-400 ppm)); Monnier, et al., The Direct Epoxidation of Higher Olefins using Molecular Oxygen, Applied Catalysis, A: General (2001), 221(1-2), 73-91 (optimum catalyst formulations for propylene or C4 epoxidation are different from those for ethylene epoxidation).

Second, even if Mikawa is properly combined with Gerdes, the combination does not render the claims obvious to one of skill in the art at the time the invention was made. Mikawa, et al., like Gerdes, et al., describes in great detail the method of *making the carrier*, by mixing an alpha alumina with a particular sodium content with an aluminum compound, a silicon compound and a sodium compound, followed by calcination of the mixture. Mikawa, et al. does not describe or suggest treating a *preformed carrier* with a modifier. Nor does Mikawa et al. provide the motivation to not only substitute its modifier for that of Gerdes but then to use the modifier to treat after the carrier is formed.

The remaining rejections: With regard to claim 14, please see applicants' response regarding the rejection of claims 2-3 above. In addition, for the reasons set forth above, the independent claims are patentable, and the rejections to the dependent claims are moot.

Applicants respectfully requests reconsideration of the rejection of claims 1-10 and 13-15 and further submit that claims 1-10 and 13-15 are in condition for allowance.

Respectfully submitted,

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